Small Amplitude Oscillatory Forcing on Two-Layer Plane Channel Flow

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Abstract

The effect of oscillatory forcing as a dynamic stabilization or destabilization mechanism for two layer plane Couette-Poiseuille flow at low Reynolds number is studied using numerical and asymptotic methods. The flow is driven by the relative planar motion of the upper boundary and a pressure gradient in the streamwise direction. Both driving forces are composed of a steady part and small amplitude time-periodic fluctuations. An asymptotic expansion for the growth rates for small amplitudes is developed and the correction terms are quadratic in the amplitudes. The modulations to the steady flow can have either a stabilizing or destabilizing influence depending upon the conditions of flow. Complete stabilization is possible for certain flows which are otherwise unstable due to the viscosity stratification across the interface. The combined pressure and velocity fluctuations can have an opposite effect on the flow stability to that induced by the separate time-periodic forcing mechanisms.